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of: carrying said wafers under vacuum in a vacuum-tight carrier comprising a body including sidewalls and also a cover closeable to make a vacuum-tight seal with said body, said sidewalls each having plural ledges thereon defining slots to hold wafers of a predetermined size, said ledges on said sidewalls having at least one surface thereof sloped to be at least 5 degrees out of parallel with the plane of said slots.

Brief Summary Text - BSTX (44):

According to the present invention there is provided: a method of transporting integrated circuit wafers during fabrication, comprising the steps of: carrying said wafers under vacuum in a vacuum-tight carrier comprising a body including sidewalls and also a cover closeable to make a vacuum-tight seal with said body, said sidewalls each having plural ledges thereon defining slots to hold wafers of a predetermined size, said ledges on said sidewalls having at least one surface thereof sloped to be at least 5 degrees out of parallel with the plane of said slots; said carrier further comprising an elastic element on an inner surface thereof, said elastic element holding wafers of said predetermined size secure against free movement.

Brief Summary Text - BSTX (45):

According to the present invention there is provided: a method of fabricating integrated circuits, comprising the steps of: transporting integrated circuit wafers during fabrication, comprising the steps of: carrying said wafers under vacuum in a vacuum-tight carrier comprising a body including sidewalls and also a cover closeable to make a vacuum-tight seal with said body, said sidewalls each having plural ledges thereon defining slots to hold wafers of a predetermined size, said ledges on said sidewalls having at least one surface thereof sloped to be at least 5 degrees out of parallel with the plane of said slots; said carrier further comprising an elastic element on an inner surface thereof, said elastic element holding wafers of said predetermined size secure against free movement.

Detailed Description Text - DETX (16):

The transfer arm 28 preferably has two degrees of freedom. One direction of motion permits the transfer arm 28 to reach into carrier 10 or through port 30 into the adjacent processing chamber. The other degree of freedom corresponds to vertical motion of the transfer arm 28, which permits selection of which wafer inside the carrier 10 is to be removed, or which slot a wafer is to be placed into.

Detailed Description Text - DETX (19):

In the presently preferred embodiment, a linkage is used inside the rotatable transfer arm support 44, to permit the transfer arm 28 to move very compactly. The transfer arm support 44 is preferably connected to a rotating rod which is driven by the arm drive motor 34, but the arm support 44 is preferably mounted on a tubular support 46 which does not rotate. An internal chain and sprocket linkage is preferably used so that the joint between arm support 44 and transfer arm 28 moves with twice the angular velocity of the joint between arm support 44 and tubular support 46. (Of course, many other mechanical linkages could alternatively be used to accomplish this.) This means that, when the arm support 44 is in its home position, a supported wafer 48 will be approximately above the tubular support 46, but when the arm support 44 is rotated 90 degrees with respect to the tubular support 46, the transfer arm 28 will have been rotated 180 degrees with respect to the arm support 44, so

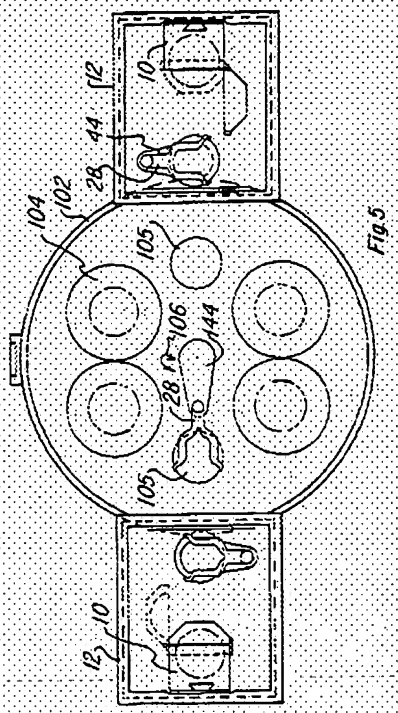

Fig. 5

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US-PAT-NO: 6499777

DOCUMENT-IDENTIFIER: US 6499777 B1

TITLE: End-effector with integrated cooling mechanism

—— KWIC ——

Detailed Description Text - DETX (29):

To further increase the thermal capacity of the end-effector 100, one can increase the average coverage (e.g., by downsizing or eliminating the slots 113 for the wafer lift pins) and/or thickness of the end-effector 100, either of which would increase the end-effector's mass. The illustrated paddle portion 115 has a thickness of about 0.115 inches. In other arrangements, a paddle for transporting 300-mm wafers can have a thickness of greater than about 0.130 inches. One can also change the end-effector 100 material, since the thermal capacity is directly related to the density (mass) and the specific heat of the end-effector 100 material. However, there are practical limits on increasing these dimensions. For example, the spacing between slots in a standard wafer storage cassette effectively limits the thickness of the wafer support 115, which inserts wafers in the cassette. For 8-inch (200 mm) wafers, this spacing is typically about 0.25 inches. Additionally, a more massive end-effector can absorb more heat from sequentially processed and transferred wafers, but dissipation of this heat is more difficult.

US Reference Patent Number - URPN (5):

5080549

US Reference Group - URGP (5):

5080549 19920100 Goodwin et al. 414/744.8

US006499777B1

(12) United States Patent
Wang

(10) Patent No.: US 6,499,777 B1
(45) Date of Patent: Dec. 31, 2002

(54) END-EFFECTOR WITH INTEGRATED COOLING MECHANISM

(75) Inventor: Albert Wang, Moraga, CA (US)

(73) Assignee: Mattson Integrated Systems, Inc., Richmond, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: 09/565,633

(22) Filed: May 5, 2000

Related U.S. Application Data

(60) Provisional application No. 60/133,566, filed on May 11, 1999.

(51) Int. Cl.⁷ B65G 49/07

(52) U.S. Cl. 294/1.3; 414/225.01; 414/935; 414/936; 414/937; 414/941; 414/941; 118/728; 165/80.3; 901/32

(58) Field of Search 294/1.1, 27.1, 294/32, 902, 64.1–64.3; 414/935–941, 222.1, 222.01, 222.12, 222.13; 225.01, 744.1; 118/724, 725, 728, 729; 34/82, 66, 428, 443, 68, 72, 75, 459, 430, 433; 62/3.2, 62; 901/30, 31, 37, 50; 165/80.1–80.3; 156/345

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6,000,227	A		12/1999	Kroeker	62/[illegible]
6,073,366	A	*	6/2000	Aswad	34/367

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JP	03224235	10/1991
JP	04278121	6/1992
JP	07041536	2/1995

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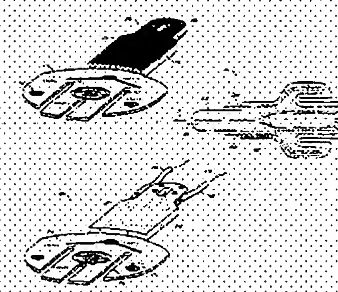
Primary Examiner—Christopher P. Ncoused

(74) Attorney, Agent, or Firm—Knobbe, Martens, Olson & Bear LLP

(57) ABSTRACT

An end-effector with integrated cooling features comprises heat transferring mechanisms that transfer heat energy away from the end-effector. The end-effector advantageously minimizes the cooling overhead of a processed substrate as it is transported from a process module to a low-cost storage cassette. The reduced cooling overhead of the processed substrate, as a consequence, improves substrate throughput. In the preferred embodiments, the heat transferring mechanisms include a high surface area heat sink connecting the substrate-supporting paddle with a robot arm. Cooling fins can enhance surface area and thus enhance heat dissipation from the heat sink. Cooling channels can extend through paddle and heat sink, either containing circulating fluid for carrying heat beyond the end-effector or a phase changing material in an enclosed heat pipe.

22 Claims, 7 Drawing Sheets



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US-PAT-NO: 6199927

DOCUMENT-IDENTIFIER: US 6199927 B1

TITLE: Robot blade for handling of semiconductor substrates

—— KWIC ——

Brief Summary Text - BSTX (5):

Semiconductor processing has been automated in recent years, to provide both efficiency in processing steps and to avoid contamination of the semiconductor substrate which might otherwise occur. As a part of this automation, semiconductor substrates, typically thin wafers, are frequently stored in cassettes to await further processing. In the most commonly used cassette designs, the wafers are horizontally oriented within the cassette with minimal spacing between each wafer. To place the wafers within the cassette and remove them without damage to or contamination of the wafers requires the use of specially designed robot-opted wafer handling equipment.

Brief Summary Text - BSTX (6):

U.S. Pat. No. [illegible] to Schwartz et al., issued Nov. 4, 1986 describes a vacuum pick suitable for removing semiconductor wafers from and replacing wafers in a cassette holder. The vacuum pick includes a thin profile housing having a wafer support surface with a cavity therein, a resilient, flexible member covering a portion of the cavity to form an enclosure, and a rigid chuck mounted on the flexible member to permit movement of the chuck relative to the housing. Vacuum is applied to the enclosure so the wafer and the chuck are retracted against the housing and held firmly in place.

Detailed Description Text - DETX (3):

Generally, the substrate handling apparatus obtains the substrate from one location and transfers it to another within the processing system. FIG. 10A illustrates a three dimensional view of a known batch heating cassette 10 used for large substrates 32 of the kind used in the fabrication of liquid crystal displays. FIG. 10B shows a cross-sectional view of the cassette 10 illustrated in FIG. 10A, with the substrates 32 in place upon heating shelves 33 within the cassette 10. These Figures illustrate the close spacing between the stored semiconductor substrates 32 within the cassette 10. With reference to FIGS. 10A and 10B, a typical heating cassette 10 comprises sidewalls 12 and 14, and a bottom wall 16. A lid 18 is fastened to the top of the sidewalls 12 and 14. Additional side walls 13 and 15 close opposing ends of sidewalls 12 and 14. Sidewall 13, adjacent system chamber 50 is fitted with a slit valve 11 through which the substrate 32 can be transferred into and out of the cassette 10, in the direction indicated by the arrow 64.

US Reference Patent Number - URPN (4):

[illegible]

US Reference Patent Number - URPN (6):

[illegible]

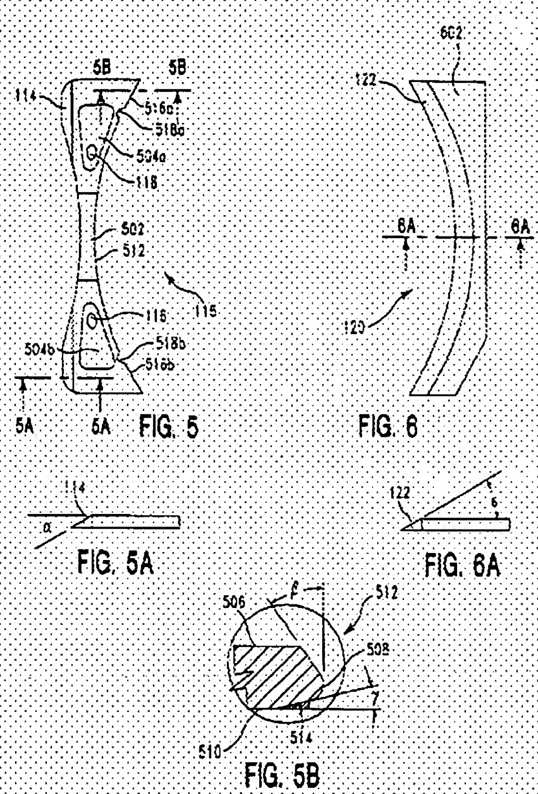

FIG. 5 FIG. 6 FIG. 5A FIG. 6A FIG. 5B

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US-PAT-NO: 5425611

DOCUMENT-IDENTIFIER: US 5425611 A

TITLE: Substrate handling and processing system

—— KWIC ——

Brief Summary Text - BSTX (4):

In U.S. Pat. Nos. 4,311,427 and 4,749,465, similar vacuum processing systems are disclosed wherein individual substrates are processed while in a common vacuum environment. In the noted patents, as in many coating systems which employ a substrate transport system, the various fixed and moving parts of the transport system frequently become at least partially coated incidentally along with the substrate. The flaking of deposited material from the transport system, especially from the moving parts, leads to the generation of particulates which may be detrimental to the substrates. This leads to the need for frequent, and sometimes extensive, servicing of the noted substrate transport systems.

Detailed Description Text - DETX (11):

The lift blades 11, 12 are guided for movement up and down in a vertical path intersecting the conveyer system 1 at right angles. The width of the blades 11, 12 is less than that of the spacing between the main walls of the cassettes 2 which hold the substrates. The blades 11, 12 are also thinner than the spacing between adjacent substrates retained in the cassettes 2.

US Reference Patent Number - URPN (2):

4500407

US Reference Group - URGP (2):

4500407 19850200 Boys et al. 414/217

U.S. Patent June 20, 1995 Sheet 5 of 5 5,425,611

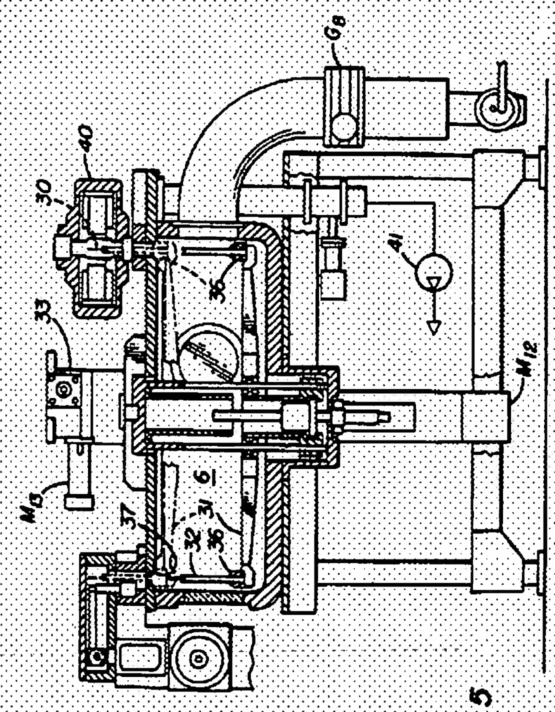

FIGURE 5

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